Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of the Commission's Rules	)	CC Docket No. 94-102
To Ensure Compatibility with	)	
Enhanced 911 Emergency Calling Systems	)	

VOICESTREAM REPORT ON IMPLEMENTATION OF PHASE II AUTOMATIC LOCATION IDENTIFICATION

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VoiceStream Wireless Corporation ("VoiceStream"), in compliance with Commission Rule 20.19(i) and consistent with the guidance that the Wireless Telecommunications Bureau has provided,[1] submits this Report describing its implementation of wireless E911 Phase II automatic location identification ("ALI"). The information in this Report supplements the extensive information that VoiceStream submitted to the Commission on October 2, 2000 as part of its semi-annual E-OTD reporting requirement.[2]

I. Introduction

The Commission's Phase II E911 rules require CMRS carriers to provide customer location information that is far more precise than is available with the Phase I, serving cell site information. The Phase II implementation deadlines that the Commission has imposed on carriers are very aggressive. VoiceStream is nonetheless committed

[1] *See* 47 C.F.R. § 20.19(i), and *Public Notice*, "Wireless Telecommunications Bureau Provides Guidance on Carrier Reports on Implementation of Wireless E911 Phase II Automatic Location Identification," DA 00-2099 (Sept. 14, 12000)("*ALI Report Guidance Public Notice*"). *See also Fourth E911 Memorandum Order*, CC Docket No. 94-102, FCC 99-326, at ¶¶ 78-81 (Sept. 8, 2000)("*ALI Reconsideration Order*").

[2] *See* VoiceStream Semi-Annual Report, CC Docket No. 94-102 (Oct. 2, 2000).

to meeting the Commission's deadlines, and it believes at this point in time that it should be able to meet the deadlines.

Three caveats are in order, however. First, VoiceStream is a telecommunications carrier. It does not manufacture the equipment used within its network (and which must be modified for Phase II compliance). Nor does it manufacture the handsets that must be modified in order for VoiceStream to comply with the Commission's Phase II requirements. While it has placed orders or is in the process of negotiating contracts with its vendors and while it has some influence over its vendors, VoiceStream does not control the manufacturing process and therefore cannot ensure that some technological glitch, which can be common with any new capability, will not delay deployment. Its vendors are confronted with competing product development demands from other carriers, some of whom have substantially higher purchasing power than does VoiceStream.

Second, it is important to remember that the benefits of Phase II technology will be realized *only* if the thousands of PSAPs across this country upgrade their equipment and E911 networks to accommodate the new technologies that carriers are deploying. The most important task at this point is to ensure that all PSAPs (and their CPE/network vendors) understand the steps they must take to take advantage of the Phase II location capabilities. For example, PSAPs must begin mapping their service areas so their equipment can interpret and intelligently use the latitude and longitude information that CMRS carriers will soon be capable of supplying. This is no simple matter, and the mapping process alone can take months to complete. The sooner PSAPs begin this effort, the sooner they can begin to support Phase II land the sooner they will be able to serve more fully the residents of and visitors to their PSAP service areas.

Third, while VoiceStream is committed to meeting the Commission's aggressive Phase II implementation deadlines, the Commission must understand that there are significant challenges with introducing and deploying extensively new technology at such a rapid pace without the benefit of adequate testing of new components or integration of components into the existing network. VoiceStream is committed to meeting the Commission's deadlines. It is also committed to providing a quality product to its customers and to PSAPs. VoiceStream will promptly advise the Commission if it believes that effective and timely deployment will be jeapordized due to inadequate testing.

II. Background/Contact Information

A. Carrier Identifying Information. This Report is submitted by VoiceStream Wireless Corporation, and its TRS numbers are 814913, 814914, and 818926.

B. Contact Information. Questions regarding this Report should be addressed to:

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III. E911 Phase II Location Technology Information

VoiceStream below provides the information that the Wireless Bureau identified in its September 14, 2000 *ALI Report Guidance Public Notice.*

A. Type of Technology.

VoiceStream intends to implement throughout its nationwide GSM network the "hybrid" solution that the Commission recently approved in its *ALI Reconsideration Order*.[3] There are two components to VoiceStream's Phase II implementation plan. First, VoiceStream will provide a "safety net" feature that will be available to all users of VoiceStream's network, whether they are VoiceStream customers or roamers from other GSM carriers. Known as the Network Software Solution ("NSS"), this safety net capability will provide a level of accuracy more precise than is available with Phase I cell site location capability (specifically, accuracy of 1000 meters for 67 percent of calls), and VoiceStream will be capable of supporting this enhanced NSS location capability for all existing (or legacy) handsets.

The second component of VoiceStream's Phase II solution is a handset solution, known as the Enhanced Observed Time Difference of Arrival, or "E-OTD." This E-OTD solution will provide much more precise location information than is available with either Phase I or the Phase II NSS "safety net" solution. However, E-OTD requires upgrades to infrastructure and to handset software in order to take advantage of this advanced location capability. Its negotiations with infrastructure and handset vendors are ongoing. VoiceStream remains committed, nonetheless, to meeting the Commission's requirements — namely, that 50 percent of all new handsets activated after October 1, 2001 be

[3] *See Fourth E911 Memorandum Order*, CC Docket No. 94-102, FCC 99-326, at ¶¶ 55-68 (Sept. 8, 2000) ("*ALI Reconsideration Order*").

E-OTD compatible, and that 100 percent of all new handsets activated after March 31, 2002 be E-OTD compatible.

VoiceStream's current intention is to deploy the same location technology across all of its networks, although this approach could be modified if necessary. Finally, the information requested in the *ALI Report Guidance Public Notice* under this section regarding vendors is provided later in this report, in the section entitled "Implementation Details and Schedules."

B. Testing and Verification.

This section describes how E911 Phase II compliance testing will be carried out within VoiceStream's markets. The methodology is based on OET Bulletin 71, "*Guidelines for Testing and Verifying the Accuracy of Wireless E911 Location Systems,*" as issued by the FCC on April 12, 2000.

The OET 71 guidelines provide two main methods of compliance verification: empirical testing in a live market and predictive modeling of specific ALI technologies using an industry accepted model that accurately represents the technology independent of the operating areas in which it may reside. VoiceStream has investigated both methods and has not identified a suitable computer model for predictive testing. In the future, should such a model be developed which can perform this function in multiple geographical areas, VoiceStream may choose to pursue this method of testing in the interest of time and resources.

It may prove possible that the NSS "Safety Net" solution may be tested using a predictive method, as that technology is considerably less complex. VoiceStream is currently investigating predictive methods to determine the accuracy of the NSS in different

environments and such methods will be correlated against known drive test data to verify the accuracy of the prediction. Should the predictive methods prove unreliable, empirical methods can be used to verify NSS accuracy compliance.

To verify the accuracy of E-OTD, VoiceStream will use empirical drive test methods until suitable predictive modeling methods are available. The first step in verification is to choose a suitable test area. OET Bulletin 71 states that, "Reports of compliance testing should clearly define the subject geographical areas." While NENA has proposed that a carrier's entire advertised coverage area be subjected to testing, the FCC recognizes that these are typically large areas and initial ALI deployment may proceed more gradually. The determination of test areas will be based on a number of factors including the deployment schedule, testing schedule, E911 call distribution, and the size of the PSAP coverage area relative to the service area where an operator provides commercial service. No test area will include areas where VoiceStream service is not available. If a VoiceStream market service area is covered by multiple PSAPs, the test area at minimum will include the PSAP(s) which have requested Phase II information. In this instance the test area may be as large as the entire market service area if VoiceStream has completed installation and commissioning of all necessary ALI equipment. If the compliance testing is chosen to be performed by PSAP area, the individual PSAP testing areas will not overlap. Further guidance from the FCC on the issue of testing areas would prove useful for carriers and PSAPs alike.

Once the test area is defined, the next step for the empirical test is the distribution of test locations throughout the testing area. In the OET Bulletin 71 guidelines the FCC "states a preference for using data on wireless 911 call location information, if available."

VoiceStream has access to traffic statistics, which will show the number of 911 calls made in each cell in each market for a particular period of time. By bounding the urban, suburban, and rural areas of a market and using the call statistics VoiceStream can determine what percentage of 911 calls in a particular market area originate from urban, suburban, and rural areas.

1. NSS

VoiceStream has performed simulations on the NSS method, using Cell ID and Timing Advance only. The simulation model assumes a 1km inter-site distance for urban environments, a 5km inter-site distance for suburban environments, and a 15 km inter-site distance for the rural environments. The model takes into account shadow fading and antenna patterns, and assumes a random distribution of mobiles. These results are presented in Table 1.

Environment	**Cell Radius**	**Site to Site Distance**	**67% Percentile**	**95% Percentile**
Urban	670m	1000m	200m	450m
Suburban	3350m	5000m	1000m	2100m
Rural	10,000m	15,000m	3000m	6400m

Table 1 -- VoiceStream Cell ID & TA Simulation Results

These simulation results show that for urban and suburban environments the 1000m/67 percent accuracy requirement is met. Improvements in the measurement accuracy will be achieved by incorporating signal strength measurements.

VoiceStream also commissioned Omnipoint Technologies (now Xircom) to independently look at the possible accuracies of software-only NSS solutions. Omnipoint Technologies used a form of Kalman filtering to estimate the basic NSS performance.

Their simulation tool used different network assumptions, and these assumptions as well as simulation results are shown in Table 2.

Environment	**Cell Radius**	**Site to Site Distance**	**67% Percentile**
Urban	1500m	2250m	470m
Suburban	2000m	3000m	475m
Rural	7000m	10,500m	1560m

Table 2 -- OTI NSS Simulations

Both simulations described above suggest that the NSS solution should be capable of exceeding the FCC requirement of 1000m accuracy in most environments.

2. E-OTD Testing

VoiceStream has been conducting ongoing testing and verification of an E-OTD prototype system in suburban Houston since June 2000 with Cambridge Positioning Systems (CPS). Members of GSM North America (GSMNA) and most major GSM infrastructure suppliers were also participants in the trial and testing process.

The system has been upgraded several times since inception, and subsequently tested as new improvements are made available by CPS. The testing is ongoing to provide a test bed for new implementations of E-OTD handsets as they become available. The testing to date has included two stages, and a third stage is currently ongoing in Houston.

a.) E-OTD Stage I

Stage I testing was conducted between July and August 2000 and was designed to give some preliminary results for all parties involved in the trial. As much of the system was not then commissioned, a 22 Km^2 area was designated as the testing area to draw accuracy results from. The specifics of the tests were:

- 22Km^2 test area

- 26 pre-determined random locations used in commissioning process
- Testing under idle-mode (non-call) operation
- In-vehicle and outdoor testing
- No in-building testing
- Measurements spaced three minutes apart to insure statistical independence
- Over 1000 measurements collected over two weeks across 26 locations

The results are shown below in Table 3:

All measurements		**Inside the vehicle**		**Outside the vehicle**
58.6 % within 50 m		55.5 % within 50 m		61.8 % within 50 m
92.0 % within 100 m		92.4 % within 100 m		91.6 % within 100 m
97.5 % within 150 m		97.5 % within 150 m		97.6 % within 150 m

Table 3 – Stage I Trial Results

Trial partners were part of the Stage I testing and were present at testing on the dates July 31 – August 11 to get a "live feel" for the system performance and testing procedure.

b.) E-OTD Stage II

Stage II testing was started in mid-August 2000, shortly after Stage I concluded. The objectives of Stage II included the following:

- Larger test area
- Many test locations (randomly distributed)
- Dedicated mode testing (in-call)
- Testing in a moving vehicle
- In-building testing
- Test new CPS positioning algorithms
- OET71 type test regime

Stage II testing was carried out between October 4-6, 2000 by VoiceStream and CPS personnel. Using a computer program, more than 50 locations were selected for OET71 type testing. All of the OET71 guidelines were followed with the exception of testing in dedicated (in-call) mode, as dedicated mode handset software was not available at the

time. In-building testing was not possible because most of the area is residential, and VoiceStream did not have access to private residences. Nearest accessible locations were thus chosen, in accordance with OET71. At each location, five location measurements were performed spaced three minutes apart. Table 4, which follows, summarizes the results of Stage II testing:

E-OTD Stage II Results
67.0 % within 75.7 m
77.1 % within 100 m
98.3 % within 300 m

Table 4 – Stage II Trial Results

On October 9 and 10, GSMNA trial partners were on-site in Houston to perform testing and get a "hands-on" feel for the dedicated mode mobile testing, moving mode testing and algorithm improvements in the system. During these days the first testing of the dedicated mode software and moving mode software was performed. At this time these new software additions are available on separate mobile software loads, although the software is presently being merged to support dedicated, idle, stationary and moving measurements.

Dedicated mode performance was tested further after October 9 and 10 in side-by side comparisons with the idle mode phone. Testing of 56 random locations within the Stage II trial area showed that the dedicated mode phone performs as well as the idle mode. VoiceStream believes that the dedicated mode phone should perform substantially better than the idle mode considering the phone is making neighboring cell measurements much more often (a full set approximately every 5-12 seconds, as opposed to approximately every 30 seconds for idle mode). This was the first dedicated mode software

tested, however, and further steps need to be undertaken to take full advantage of the additional measurements and show additional timing function improvements.

Moving mode measurements were conducted during October 9 and 10 and carried out in idle mode. The testing procedure involved logging the DGPS coordinates throughout the day as the testing teams were doing some "hands on" system testing throughout the Stage II area. The moving mode mobile was placed in-vehicle and set to send location information every three minutes. At the end of the day the DGPS reference log file was compared with the measurements logged by the Mobile Location Center (MLC). This proved to be a difficult task due to the unsynchronized time stamps generated by the DGPS unit and the MLC. The mechanism for transferring the mobile measurements back to the MLC is via Short Message Service (SMS), a text messaging service standardized in GSM. SMS suffers from some latency due to traffic load as it uses a queing mechanisms at various points within the network. This resulted in some MLC location calculations which were delayed as much as two minutes from the time the mobile made its measurements. Due to equipment manufacturers' inability to produce base station subsystem (BSS) software and switching software to support the standardized GSM messaging for location services (E911) within the time frames, however, the only suitable choice was SMS.

Further, considering that some of the driving environments reached highway speeds, this did not allow for accurate time/location alignment. As a result VoiceStream and CPS were not able to align the DGPS reference logs with the MLC logs to properly generate accuracy statistics. The plots of the two sets of data were plotted over each other, however, and the E-OTD results followed the DGPS reference very closely.

C. Implementation Details and Schedule.

The safety net NSS solution requires hardware and software upgrades to VoiceStream's network, specifically, the Mobile Location Center (MLC). The MLC contains two functional components. The first is the Serving Mobile Location Center (SLMC), which will provide the location calculation point, will schedule the position calculation, and will interface with the GSM radio network to either the Mobile Switching Center (MSC) or the Base Station Controller (BSC). The second component, the Gateway MLC, will act as the point of interface to the PSAP's E911 network.

The Commission has required VoiceStream to have its NSS solution operational "by or before December 31, 2001."[4] For VoiceStream to meet this deadline, its network vendors must deliver all necessary equipment to VoiceStream during the third quarter of 2001. VoiceStream needs a minimum of 90 days to install and test the equipment throughout its nationwide network.[5]

The E-OTD solution requires both network upgrades as well as software upgrades to handsets. Within the network, VoiceStream must install a Location Measurement Unit (LMU) at its base stations. The Commission has required that VoiceStream be capable of supporting E-OTD location within six months of a PSAP request or by October 1, 2001, whichever is later.[6] To meet the October 1, 2001 deadline in areas where a PSAP has placed a Phase II request by April 1, 2001, VoiceStream will require that its vendors deliver by July 1, 2001, a sufficient number of LMUs so it has time to install and test LMUs within the requesting PSAP's service area.

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[4] *See ALI Reconsideration Order* at ¶ 61.

[5] The Commission should recognize that a 90 day installation/testing period when applied to a nationwide network is very aggressive.

The E-OTD solution also requires modified handsets that are capable of providing and measuring the information that the network needs for its calculations. The Commission has directed that 50 percent of all new handsets sold after October 1, 2001 be E-OTD compatible and that 100 percent of all new handsets sold after March 31, 2002 be E-OTD compatible. While VoiceStream's negotiations with handset vendors are continuing, at least one handset vendor has indicated that it should have several product lines of E-OTD compatible handsets available as early as July 2001, with another vendor indicating that its E-OTD compatible handsets will be available during the fourth quarter of 2001.

With respect to infrastructure, all of VoiceStream's vendors have indicated that they will have NSS solutions available by Q4, 2001. Two vendors have indicated, however, that additional testing may be necessary before full release of "live" information to PSAPs. If so, VoiceStream and its vendors would need to reassess the risk of releasing the software early to meet PSAP requests, as it would not be in the PSAPs' or the public's interest to release "live" information derived from undertested software. At this point, VoiceStream is confident that its vendors can deliver and test systems in time for the December deadline, but will apprise the Commission as the situation warrants.

SMLC and GMLC platforms will be deployed initially to support NSS and will be upgraded to support E-OTD. The necessary LMU hardware will be available beginning Q4, 2001. Once sufficient LMU hardware is available, network deployment and tuning can commence. Based on an estimated deployment of 90 days, E-OTD based positioning will be available end of Q4, 2001 for a limited set of markets. Full-scale deployment will

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[6] *See ALI Reconsideration Order* at ¶ 65.

be available in Q1, 2002. Because only a limited number of PSAPs are expected to be able to accept the Phase II positional information by Q4 2001, the availability of LMUs and the time needed to deploy in the field should not be problematic. However, if the number and scale of PSAP requests for deployment is larger than expected, then there is a risk there could be delays in deployment in some markets.

D. PSAP Interface.

VoiceStream will not need to make any changes to transmit Phase II data to the PSAPs since VoiceStream uses SS7, FGD or enhanced MF as they have been standardized for 9-1-1. This also should obviate the need for any PSAP changes if the Phase 1 solution in place can migrate to Phase 2. This migration ability has been a cornerstone of the Phase 1 technology choice debate. Although some NCAS proponents insist NCAS is the 'only' solution the CAS proponents feel exactly the opposite.

VoiceStream's position continues to be that we will not sign a contract for third party NCAS hardware because this hardware is part of the 9-1-1 network and, as such, it should be provided by the PSAP or the LEC. VoiceStream will work with whichever third party NCAS provider the PSAP has identified and use its best efforts to make deployment problem-free.

VoiceStream has received only one valid Phase II request (City of Chicago) thus far. We anticipate that the Phase II request rate will be low because the PSAPs must undertake a great deal of equipment upgrading to be in a position to effectively use the data. They also must have completed their mapping efforts (mapping is vital to selective routing and to both Phase I and Phase II). In most cases they will also need an accurate electronic map on which to display the data. (In some cases they can do this using simple

street addresses but this is not optimal by any means.) They must also train their personnel to effectively interpret and use the data during 9-1-1 call processing.

E. Existing Handsets.

As discussed above, VoiceStream's "safety net" NSS solution will provide reasonably precise location information for all current handsets. VoiceStream also notes, however, that mobile customers have a history of replacing their handsets relatively frequently, and recent studies suggest that consumers will begin accelerating the replacement of their handsets to take advantage of new capabilities that mobile carriers are introducing. For example, according to a study released by Herschel Shosteck Associates earlier this week, the phone replacement rate will reach 50 percent in 2003 and sales of replacement phones will surpass sales of first phones to new subscribers.[7] Nokia recently predicted that phone replacement rates could be as high as 70 percent to 80 percent in coming years.[8]

F. Location of Non-Compatible Handsets.

Locating legacy handsets is of particular importance in any handset-based ALI technology, including E-OTD. VoiceStream has recognized this and proposed the NSS "Safety Net" as a solution to provide a level of legacy support to all VoiceStream subscribers and roaming customers, regardless of their handset type. The accuracy of the NSS solution is higher than that available in E911 Phase I (cell ID). The NSS solution also creates a more accurate backup solution to instances where the E-OTD system may not be able to perform a location measurement.

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[7] *See* "Mobile Phone Replacement Rate Rising," http://biz.yahoo.com/rf/001107/n0714302.html (Nov. 7, 2000).

[8] *See id.*

IV. Conclusion

VoiceStream has developed a plan that is designed to meet the Commission's Phase II E911 requirements. However, there are a number of contingencies that must be met in order to achieve these deadlines (*e.g.*, significant problems do not arise in field testing, and vendors are capable of delivering production quality network equipment and handsets). VoiceStream will keep the Commission apprised should such contingencies materialize. Furthermore, Phase II will not be implemented in a timely fashion without the cooperation of carriers and PSAPs. VoiceStream is fully prepared to work with the PSAPs to do all that is possible to ensure timely delivery of these vital services to the public.

Respectfully submitted

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